

Synthesis of $\text{Au}_x\text{Ag}_{1-x}$ nanowire-networks with controlled composition and defined wire diameter

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In this work, three dimensional AuAg-alloy-nanowire-networks with controlled composition and defined wire diameter were fabricated by electrodeposition in ion-track etched polymer templates. These structures are very interesting for applications in sensorics and catalysis since they exhibit a very high surface area and are mechanically stable due to their interconnected nanowires.

For the synthesis of the nanowire-networks, we have irradiated 30 μm -thin polymer foils at the GSI linear accelerator UNILAC with swift heavy ions of initial energy 11.4 MeV/u. Each foil is sequentially irradiated four times under an angle of 45° respective to the polymer surface. The ions damage molecular bonding in the foils and create cylindrical damage tracks. By chemical etching with aqueous 6-M NaOH solution at 50° C these ion tracks are transformed into nanochannels. Under these etching conditions, the etching rate amounts 23 nm/min. By varying the etching time between 2 min and 5 min nanochannels with defined diameter between 60-150 nm were fabricated. After creating a conductive cathode layer by sputtering gold on one side of the foil, nanowires are electrodeposited in the pores. We have deposited AuAg-nanowires using an electrolyte consisting of 50 mmol $\text{KAu}(\text{CN})_2$ and 50 mmol $\text{KAg}(\text{CN})_2$ in a three-electrode set-up. A Ag/AgCl electrode was used as reference electrode and a platinum coil as anode. All deposition potentials are given here vs. Ag/AgCl reference. Wet-chemical dissolution of the polymer leads to free-standing stable nanowire-networks. Fig. 1 shows the SEM image of a network with 100 nm wire diameter.

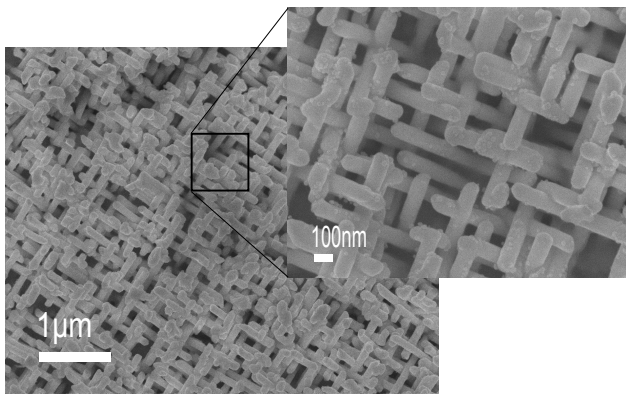


Figure 1: SEM image of a AuAg-nanowire-network with a wire diameter of 100 nm.

The applied voltage during the deposition was varied to create nanowires with controlled Au:Ag concentrations.

Fig. 2 shows details of EDX in SEM spectra including the M_{α} -peak of Au and L_{α} - and L_{β} -peak of Ag. All spectra are normalized to the height of the M_{α} -peak for clarity. Table 1 shows the concentration for networks deposited at voltages between -0.6 and -0.8 V. For the networks at -

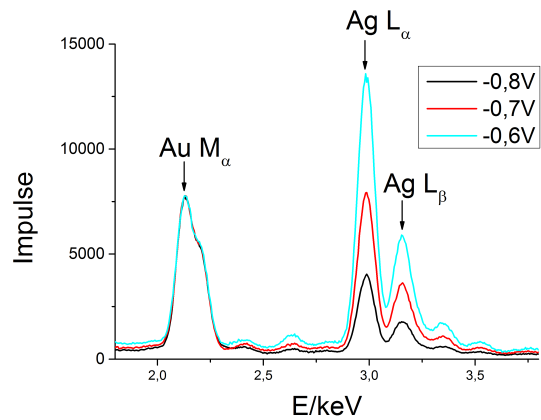


Figure 2: EDX spectra of AuAg-alloy-nanowire-networks deposited at different voltages in the range between -0.8 and -0.6 V.

Potential/V	Networks Au:Ag[%]	Parallel arrays Au:Ag[%]
-0,8 V	50:50	20:80
-0,7 V	30:70	-
-0,6 V	20:80	-

Table 1: Au:Ag ratio in the nanowires of networks and parallel arrays for different deposition potentials.

0.8 V the same Au:Ag concentration in the nanowires is found as present in the electrolyte. In contrast, for arrays consisting of parallel nanowires a Au:Ag concentration of 20:80 was measured at this potential [1]. We attribute this difference in wire composition between parallel nanowire arrays and networks to variations in the diffusion process, due to interconnections among pores and the different effective lengths.

References

[1] I. Alber, "Synthesis and Plasmonic Properties of Metallic Nanowires and Nanowire Dimers", PhD thesis, Ruprecht-Karls-Universität Heidelberg, 2012.